

Evaluation of Grip Loss

A Factor of Permanent Partial Disability in California: Summation and Conclusions of the Subcommittee for Study of Grasping Power of the Committee on Industrial Health and Rehabilitation of the California Medical Association

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UPON REVIEW of the medical literature on injuries of the hand, it was noted that scarcely a line has been written concerning the problem of evaluation of loss of grasping power. The only complete report that has been published to date on this subject is a paper by Barritt.² The only other reference found in the recent literature on the use of an instrument for measuring grasping power is the report of the Subcommittee for Standardization of Joint Measurements in Industrial Injury Cases contained in a book titled "Evaluation of Industrial Disability" which was compiled by Thurber.⁴ In this book a pneumatic dynamometer is mentioned, a picture of the Geckeler dynamometer is shown, and the subject concerning grasping power is briefly discussed.

At present there are only three types of instruments available to determine comparative loss of grasping power between the injured and normal hand. The Geckeler dynamometer is a pneumatic instrument which depends upon the compression of a column of air by means of a conventional rubber bulb, such as is used on a blood pressure cuff, to propel air into a gauge which registers the increase in air pressure produced by pinching the bulb. At one time there was an idea that a blood pressure cuff could be rolled up and inflated and that a comparative determination of grip could be obtained by having the patient squeeze the partially inflated cuff. It was found that differences in basal starting pressures could produce almost any kind of reading, and that bounce by a quick jerk could squirt the mercury or dial hand through its entire range and give completely abnormal and improper readings. Barritt stated that the use of the blood pressure cuff in the taking of grip measurements was not acceptable.

The Collins dynamometer, sometimes called the Misdom-Frank, is an oval spring device which depends entirely on compression of a steel spring registering the amount of compression of the spring

• Loss of grasping power is a ratable factor of permanent partial disability by the Industrial Accident Commission of the State of California. The ratings that issue therefrom are based upon the proportion of grasping power actually lost as a result of the injury sustained. The conditions which most frequently impair grasping power are, (1) amputation; (2) limited motion of digits, wrists, forearm, elbow or shoulder; (3) pain; (4) muscular weakness. The examining physician can greatly facilitate proper rating if he carefully and fully reports data needed by the I.A.C. Grip readings should be measured by the most precise instrument which can be obtained. Makeshift devices such as using a blood pressure cuff are not acceptable. A committee of the California Medical Association appointed to study the subject of loss of grip for purposes of establishing compensation rating, concluded that a dynamometer that registers pounds force is preferable to one registering pressure.

through gears which activate a pointer on a dial. The oval spring on this type of dynamometer is not made with uniform or calibrated resistance and consequently a wide variation in comparative figures can be obtained with different instruments, no two being alike in so far as resistance is concerned. Some of the instruments have a spring so weak that the comparative result is of no practical value because it offers so little stimulus to the grasping effort, and in some the spring is so strong that the resistance causes the patient to balk at applying his best efforts. Another fault frequently encountered is that the edge of the spring gouges into the soft tissue of the hand to the extent that it causes pain even in an uninjured hand, which keeps the patient from gripping his best. Some investigators have padded the spring with sponge rubber, which has helped to reduce the gouging effect.

The third type of dynamometer uses a sealed hydraulic system which registers force in pounds.

Sanderson³ described quite correctly the difference between measuring grip pressure and grip force as follows:

"It is important to emphasize that force and

Presented before the Section on Industrial Medicine and Surgery at the 85th Annual Session of the California Medical Association, Los Angeles, April 29 to May 2, 1956.

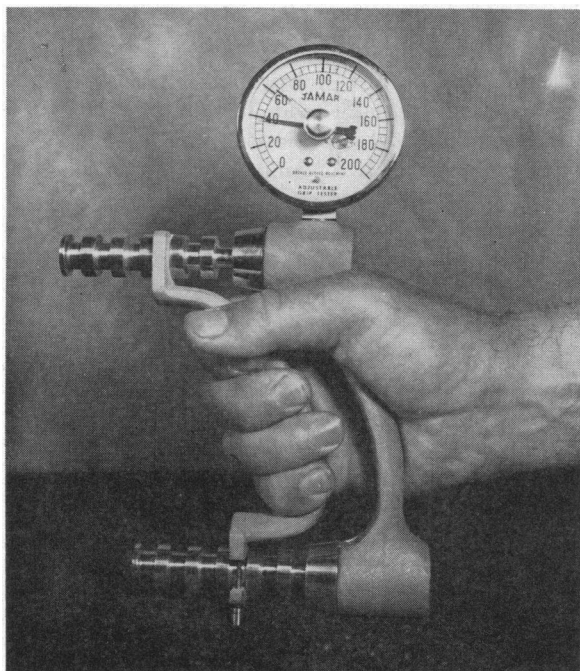


Figure 1.—Jamar dynamometer.

pressure are two widely different physical items. Pressure is the measure of an intensity of force over an area. The wide difference between force and pressure is well illustrated by the simple experience of standing on the floor on one foot, then stepping on a marble, and finally, for extreme emphasis, upon the point of an upwardly protruding nail. Exactly the same force is involved in each case. The weight is the weight of the stepper. In the first case the weight is supported by the area of contact with the entire foot and the pressure is approximately 60 pounds per square inch depending upon the weight of the stepper and the size of his foot. The pressure in the case of stepping upon a half-inch marble is approximately 760 pounds per square inch for a man weighing 150 pounds. The same man stepping on a moderately pointed nail, the diameter of the point equal to $1/50$ of an inch, will feel a pressure of approximately 478,000 pounds per square inch. The latter far exceeds the strength of the tissue and accounts for the failure of said tissue and the penetration of the nail into the foot. The important point to understand is that pressure is force divided by area. In the above illustration the same force was involved in each case but the pressure varied from approximately 60 pounds per square inch to 478,000 pounds per square inch, solely because of the effect of the change in area of contact.

"Precisely, this is the same relationship involved in measuring grip. It is impossible to correctly measure grip by measuring pressure. A small hand

or hand having amputated fingers having a moderate grip would develop a large grip pressure. A large hand, having the same useful grip as far as the ability to perform manual work is concerned, would develop a small grip pressure because the same force is spread over a large area. To employ grip measurement as a mark of ability to perform manual labor is a scientific, objective approach to the quantitative measurement of physical ability. It is important, therefore, that grip force be employed and not grip pressure.

"Devices which measure grip pressure by squeezing a bulb filled with fluid, liquid or air, or one of the common spring dynamometers, can only measure the pressure of grip. Grip can only be measured by a force-measuring instrument.

"An instrument measuring grip must respond to the force of the grip, only. Such an instrument would be properly called a Grip Dynamometer. It must not be influenced by the area of contact between the hand and the instrument. So long as the grip is the same it must show the same reading whether the squeezing hand has one or more fingers missing or whether the hand is large or small. It must show the same reading and the same value of grip upon repeated trials regardless of the person who makes the observation.

"Therefore, the basic physics of grip measurement should be summarized as follows:

- "1. Grip is a force.
- "2. Grip is not pressure.
- "3. The measurement of grip must be in force units such as the pound or the gram."

Five or six years ago Sanderson³ manufactured several instruments of the kind he advocated, and he has persistently tried to perfect them but to date such instruments are not being manufactured in any quantity.

The sealed hydraulic system instrument which this Committee* studied is the (Bechtol) Jamar dynamometer, completely remodeled and perfected to the extent that its sealed hydraulic system is as nearly leakproof as any mechanical appliance can be made (Figure 1). It is equipped with a sensitive gauge which is calibrated in pounds per square inch (pounds force), and there is a recalibrator on the face of the gauge for adjustment if any minor change in the pressure should occur. The handles are effectively shaped to fit the hand, made of aluminum, smoothly sandblasted, for comfort and light weight. When the instrument is grasped, only a small fraction of an inch of motion is required to register the

*The Subcommittee for Study of Grasping Power of the Committee on Industrial Health and Rehabilitation of the California Medical Association.

maximum reading of 200 pounds, an isometric feature.

The original Jamar grip tester was the result of three years of study by an engineer and an anatomist with the counsel of four eminent orthopedic specialists. Recently Asimow¹ reengineered and improved this instrument, retaining the isometric principle and a hydraulic system sealed under vacuum. It is now being manufactured in quantity.

The Council of the California Medical Association in October, 1954, authorized Packard Thurber, Sr., M.D., chairman of the Standing Committee on Industrial practice, to appoint a subcommittee to study and evaluate various grip measuring devices and problems concerning measurement of grasping power. Following are the names of the members of the subcommittee he appointed: John E. Kirkpatrick, M.D., San Francisco, chairman; J. L. Barritt, M.D., San Francisco, medical director of the Industrial Accident Commission, State of California; Paul Beddoe, M.D., medical examiner, Industrial Accident Commission, Los Angeles; and A. W. Hoaglund, M.D., Los Angeles, medical director of Pacific Indemnity Company.

Appointed as advisory members of this subcommittee were: Mr. Eli Welch, San Francisco, supervisor of the Permanent Disability Rating Bureau, Industrial Accident Commission; Mr. Jerry Crowley, permanent disability rating specialist, Industrial Accident Commission, Los Angeles; Packard Thurber, Sr., M.D., Los Angeles, ex-officio member.

The first meeting of this subcommittee was held on December 10, 1954, all members being present. The program of study was outlined and the committee then agreed that several Jamar instruments should be supplied to the medical departments of the Industrial Accident Commission in San Francisco and Los Angeles for trial use by their medical examiners in order to make a study of the comparative value of the several dynamometers in current use for the determination of loss of grasping power. The Council of the California Medical Association on April 3, 1955, appropriated the money to supply several of these instruments.

On June 1, 1955, Mr. S. W. McDonald, chairman of the Industrial Accident Commission, approved a survey study to be made of the different types of dynamometers used in Commission cases by the several physicians in the Medical Bureau—J. L. Barritt, M.D., Paul Beddoe, M.D., Gerald F. Doyle, M.D., Wm. H. Harrison, M.D., George Jones, M.D., Sam Kerlan, M.D., and Ben Sharpton, M.D. They made comparative tests over a period of five months.

The opinion of each of these examiners was studied at the next meeting of the subcommittee

which was held in Los Angeles on December 2, 1955. The entire subcommittee was present. Also, Jerome Shilling, M.D., chairman of the Committee on Industrial Health and Rehabilitation of the California Medical Association, was present in an advisory capacity. H. C. Sanderson, M.D., a member of this committee, could not attend. At this meeting it was decided to put the conclusions of the subcommittee into the form of an instructive article on the evaluation of grip loss.

The next meeting of the subcommittee was held on February 10, 1956, in Los Angeles. All members and advisory members were present. An outline of the paper that had been recommended at the preceding meeting was presented. Drs. Barritt, Beddoe and Thurber and Messrs. Welch and Crowley collaborated and contributed to the article outlining the evaluation of grip loss.

The information which the committee felt should be distributed to the members of the California Medical Association in pamphlet form is as follows:

EVALUATION OF GRIP LOSS IN CALIFORNIA

Loss of grasping power is a ratable factor of permanent disability in California. The Industrial Accident Commission desires that dynamometer readings of both hands be given in all examinations of an upper extremity made for rating purposes.

Ratings are based on the percentage of grasping power actually lost as a result of the injury being reported upon. In estimating this percentage the uninjured opposite hand is used as a basis for comparison. In most persons, however, the grip in the major hand is stronger than that in the minor. The Industrial Accident Commission has assumed for reasons of expediency, that the grip is 10 per cent greater in the major hand.

The determination of grip loss based on dynamometer readings is made as follows:

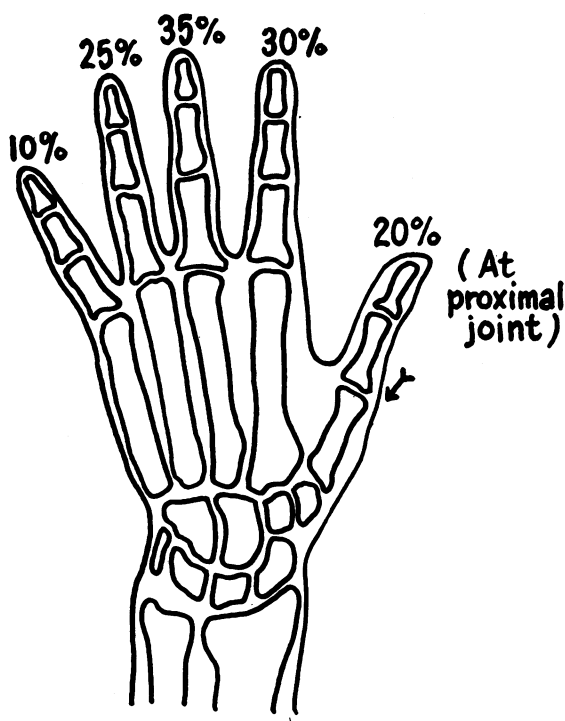
<i>Example:</i>	Injured Major	Uninjured Minor
Average of 3 dynamometer readings	70	100
	(10% greater in major)	
	Add	10
	Estimated normal ..	110
	Major actual grip....	70
	Loss	40
40/110		
(Gives 36% grip loss in major hand.)		

The factors which most frequently result in loss of grasping power are: (1) Amputation, (2) limited motion of hand, wrist, elbow or shoulder, (3) pain, (4) muscular weakness.

A careful evaluation of these factors will usually

ESTIMATED APPROXIMATE PERCENTAGE OF GRIP LOSS DUE TO AMPUTATION

FOR LOSS OF ENTIRE FINGER



FOR PARTIAL LOSS OF ANY FINGER

approximate loss at:

middle joint-
3/4 of value of finger

distal joint-
1/5 of value of finger

Figure 2

give the examiner a general idea regarding the grip loss which may be expected. It would be an extremely rare case in which only one factor contributed to grip loss, but for purpose of discussion it is assumed that the cause indicated is the sole cause.

1. Grip Loss Resulting from Amputation

Figure 2 illustrates the loss which is approximately that found following amputation alone.

Grip loss in cases of amputation will be increased

if such factors as pain, limited motion, tender stump, scars, incoordination and muscular weakness are associated.

2. Grip Loss Resulting from Limited Hand Motion

Evaluation is best made by considering the distance which the fingertips miss the mid palm in flexion. This distance should be reported in all hand injuries, preferably on the standard form supplied for the purpose by the Industrial Accident Commission (see example, page 318).

It is impossible to estimate grip loss resulting from limited motion with any degree of accuracy. The following are probably rough approximations of grip loss to be considered by the examiner to determine if the case is ready to be rated.

Estimated Approximate Grip Loss Due to Limited Motion

Fingers	Misses Mid Palm Over 2 Inches	Misses Mid Palm 2 Inches	Misses Mid Palm 1 Inch	Misses Mid Palm 1/2 Inch
Index	30%	25%	15%	5%
Middle	35	30	20	5
Ring	25	20	10	5
Little	10	10	5	0

With certain limitations of motion, a person may have a normal grip for large objects and yet have a complete loss of grip for small objects. The dynamometer readings in these cases will depend on the type of dynamometer used to some extent. If a dynamometer is used which has an adjustment mechanism to permit varying the span of the grip, the setting should be the same for each test of both hands and should be stated in understandable terms.

3. Grip Loss Resulting from Pain

In California, grip loss that is a result of pain* is just as ratable as loss due to amputation or other pathologic condition. Grip loss may result from pain in the hand, the wrist, the elbow and even the shoulder. When pain is a factor in grip loss, care should be taken to be sure that the condition is ready for rating. It should be emphasized that in many cases of injury to the hand, rating is decided upon much too early.

4. Grip Loss Resulting from Muscular Weakness

Muscular weakness existing at the time a case is ready for rating is usually associated with atrophy,

*The Industrial Accident Commission has adopted the following recommendations and definitions of subjective disability:

Subjective disability can best be evaluated by: (1) A description of the activity which produces the disability. (2) The duration of the disability. (3) The activities which are precluded and those which can be performed with the disability. (4) The means necessary for relief.

The following definitions were developed: (1) A *severe* pain would preclude the activity precipitating the pain. (2) A *moderate* pain could be tolerated but would cause marked handicap in the performance of the activity precipitating the pain. (3) A *slight* pain could be tolerated but would cause some handicap in the performance of the activity precipitating the pain. (4) A *minimal* pain would constitute an annoyance, but causing no handicap in the performance of the particular activity, would be considered as non-ratable permanent disability.

INDUSTRIAL ACCIDENT COMMISSION ROUTINE UPPER EXTREMITY MEASUREMENTS

Circumference Biceps R. 10" / 10½" Wrist /
Forearm R. 9½" / 10" Hand /
(Inches)

Motions: inj./uninj.(*)

Shoulder: Abd. / Forearm Pron. /
Flex. / Sup. /
I R. /
E R. / Wrist D F /
Ext. / P F /
Add. / R D /
U D /

Elbow: Ext. /
Flex. /

Hand: - - R. Major

		Proximal	Middle	Distal	Finger tips miss palm: inches		
Thumb	(Ext		XXXXXXXXXX		Prox.	Mid.	Dist.
	(Flex		XXXXXXXXXX				
Index	(Ext		R. 170/180	R. 165/180	1½"	1"	¾"
	(Flex		R. 90/110	R. 40/70			
Middle	(Ext						
	(Flex						
Ring	(Ext						
	(Flex						
Little	(Ext						
	(Flex						

Thumb: (Abd. / (degrees)
(
(Add. Tip misses head of 5th MC. / inch

Grip (dynamometer readings)

	Inj.	Uninj.
	96	105
	92	95
	94	100
Average	94	100

Grip loss 16/110 = 15% grip loss.

* In case of bilateral disability state estimated normal as Abd. 140/160 (estimated normal 180).

MEASUREMENTS NOT SHOWN ARE CONSIDERED NORMAL

Key to abbreviations:
Abd. = Abduction
Flex. = Flexion
I R. = Internal rotation
E R. = External rotation
Ext. = Extension
Add. = Adduction
Pron. = Pronation
Sup. = Supination
D F = Dorsal flexion
P F = Palmar flexion
R D = Radial deviation
U D = Ulnar deviation
MC. = Metacarpal
inj. = Injured
uninj. = Uninjured

and measurements of girth of arm and forearm of both injured and uninjured extremities are necessary in every rating report. Most persons doing active work have a greater girth on the major side. This difference in girth may vary from none at all in the case of frail female clerical workers, to $\frac{7}{8}$ of an inch in husky males in certain trades. Equal bilateral measurements of girth in active persons usually indicates atrophy of the major side. A small decrease in girth on the minor side usually does not mean atrophy.

5. Grip Loss from Weakened Extensor Mechanism

It should be borne in mind that before an adequate grip can be made, there must be a preliminary fixation of the extensor muscles. Without this preliminary fixation, there can be no normal grip. This is a not infrequent cause of grip loss following tenosynovitis and following certain injuries to muscles and nerves.

6. Dynamometers

The evaluation of grip loss is a medical problem involving many factors. The dynamometer is only one of the methods by which grip loss is evaluated. There is at present no type of dynamometer which will show exactly what the grip loss is.

Grip readings taken by means of a sphygmomanometer cuff or bag are believed to be very inaccurate and are not acceptable to the Industrial Accident Commission.

Two subcommittees under the sponsorship of the California Medical Association have studied the dynamometer problem. No machine has as yet proved to be entirely satisfactory. At present the Jamar* dynamometer (Figure 1) is being studied. Preliminary tests have shown it to be apparently a very good machine. The machine certainly warrants further study and may prove to be the most satisfactory of any available thus far for general use.

Any dynamometer must be used with intelligence. Some of the factors which may make dynamometer readings invalid are:

1. Preexisting injury to the extremity being examined.
2. Preexisting injury to the opposite extremity, making it unsuitable for grip comparison.
3. Failure of the patient to cooperate or to put forth his best efforts.
4. Confusion as to which is the major hand.
5. Inadequacy of the dynamometer itself.

7. Reporting Grip Loss

Premature attempts to establish a rating for any injury cause inconvenience to the employee, the

employer and the Industrial Accident Commission.

Physicians reporting on upper extremity industrial injuries can do much to prevent financial hardship to the injured workman and the employer by giving careful attention to the matter of grip. The importance of this will be realized when it is noted that complete grip loss in the major hand of a carpenter 60 years of age amounts to a pecuniary consideration of \$7,560.

If the examiner feels that the grip loss as shown by the dynamometer reading does not indicate the actual grip loss due to injury, he should so state. He should in addition give his own estimate, *in percentage*, of what he feels the actual grip loss is. (Refer to items 1 and 2 of this report.) He should state the reasons for his opinion.

The examiner should do this only after a careful evaluation of all the factors which may have caused grip loss. He should substantiate his opinion with complete measurements of both upper extremities. He should describe the original injury, if he has not already done so, as well as the course and duration of treatment and the end result.

Such statements as, "The knuckles do not blanch," and "The forearm muscles do not tighten," are not given much consideration. If there is no ability to grip, then blanching and tightening can hardly be expected to be present. On the other hand any one can simulate tremendous effort without making any actual grip.

The following should be reported in every upper extremity examination, made for rating purposes:

1. Dynamometer readings of injured and uninjured sides.
2. Girth in inches of both arms and both forearms.
3. Complete comparative measurements of each joint of the extremity, unless it can be stated that measurement has shown the joint range to be equal to the opposite normal.
4. Distance in inches which the finger tips miss the midpalm.
5. A description of any preexisting grip loss of the injured extremity.
6. A description of any preexisting grip loss of the opposite extremity, together with the examiners estimate of what the normal grip should be. (Refer to items 1 and 2.)
7. A statement regarding which is the major hand.

The upper extremity form[†] has been found by the Commission to facilitate the reporting and rating

*The Jamar dynamometer may be purchased from Asimow Engineering Company, 12505 Sarah Street, North Hollywood, California.

[†]The upper extremity Form M-35A can be obtained from the Industrial Accident Commission, San Francisco, by request to Dr. J. L. Barritt, Medical Director.

of upper extremity disabilities. In addition it saves the examining physician's time during the examination and when reporting his findings.

In conclusion, this Committee unanimously agreed that the physical principle of the pounds force type of dynamometer is more acceptable than the principle of the pressure types of dynamometers for the quantitative measurement of grasping power; and furthermore, this committee unanimously agreed to recommend the new Jamar dynamometer as the most acceptable instrument manufactured at this time, bearing in mind that with progress in engineering some better method or instrument may be

developed to more accurately study comparative grasping power.

516 Sutter Street, San Francisco 2.

REFERENCES

1. Asimow, M., Ph.D., Asimow Engineering Co., 12505 Sarah Street, North Hollywood, Calif.
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